FERMILAB

Report to the Director on the Fermilab Environment CY2004

1.0 Introduction

Environmental stewardship continued to be a guiding principle at Fermilab in 2004. That principle was translated into a working reality through the effective deployment of the environmental protection program. The environmental protection program (EPP) establishes policies and procedures to ensure compliance with regulatory requirements imposed by Federal, State and local agencies and with DOE orders. In addition, the EPP provides for the measurement and interpretation of the impact of Fermilab operations on the public and the environment via its comprehensive environmental monitoring and surveillance program.[1]

Surveillance and monitoring tasks are conducted to confirm compliance with standards and permit limits as well as ensure early detection of an unplanned pollutant release. The location and frequency of sampling are based on established routines, operational considerations and historic levels of pollutants found in each location. Sampling points are selected based on the potential for adverse impacts.

To evaluate the effects of Fermilab operations on the environment, samples of effluents and environmental media such as soil and groundwater are collected on the site and at the site boundary. These samples are analyzed and results are compared to applicable guidelines and standards. The status of environmental protection activities and the progress on environmental restoration, waste management and corrective action activities are discussed in this report. In 2004 there were no abnormal occurrences that had an impact on the public or the environment[2]; however, the operation of the facility was impacted by the Neutrinos at the Main Injector (NuMI) project (see description below).

2.0 Significant Environmental Activities

Fermilab received two environmental awards from the DOE Office of Science and one from the Illinois Governors Office in 2004. One DOE award was given for an Accelerator Division multi-year project that involved the repositioning of emergency lights, in accelerator and fixed target tunnels, to locations further away from beamline enclosures. This project was undertaken to prevent the emergency light batteries from becoming radioactivated and the subsequent creation of mixed waste. The second DOE award was given for the Particle Physics Department retrofit of the D-Zero liquid nitrogen recovery system. The retrofit dramatically increased the efficiency of the liquid nitrogen recovery system, which subsequently reduced the heat load on other systems. This resulted in an annual usage reduction of 207,000 gallons of liquid nitrogen that translates into a savings of approximately $43,000 per year. An Illinois Governor's Pollution Prevention Award was also granted to Fermilab for this retrofit.

Fermilab experienced an unexpected oil spill on August 31, 2004 resulting from the failure of equipment associated with a Central Helium Liquifier (CHL) Coldbox. The equipment contains a heat exchanger that utilizes industrial cooling water (ICW) to dissipate heat from its oil reservoir. Because the normal operating pressure of the oil side of the heat exchanger exceeds the ICW pressure, when a lead developed between the two, the oil began to contaminate the ICW. The equipment failure occurred when the oil pressure in the exchanger exceeded the water pressure and the oil contacted the cooling water. The cooling water from the heat exchanger discharges via a pipe to a manhole that is part of the site storm drainage/ICW system and

eventually accumulates in Bull Rush Pond. Approximately 27 gallons of mineral oil were released into Bull Rush Pond prior to spill discovery, source identification, and equipment shut down. The spill was confined because the only outlet from Bull Rush Pond is via a lift station whose pump inlets are too deep to entrain floating oil.

The Fermilab Fire Department initially responded to the spill by utilizing oil absorbent booms and pads. Subsequently, an environmental cleanup contractor cleaned up most of the oil on September 2, 2004. Additionally, the Accelerator Division ES&H Department personnel continued to remove residual oil from the drainage ditch until mid-November.

In response to this incident, the following actions are underway:

1. A vendor has been contracted to determine the exact failure mechanism of the heater exchanger.
2. Equipment and procedural modifications are being implemented to:
    - eliminate the potential for bacterial corrosion (a possible cause of the equipment failure)
    - ensure earlier problem detection by operators
    - containment of spilled oil prior to release into manholes
3. All divisions/sections have been asked to inventory similar equipment and evaluate the vulnerabilities of potential environmental receptors.
4. Local spill control plans will be developed/updated as appropriate.

Piezometers (hydrostatic pressure measuring instrument), installed as part of the NuMI site characterization, were monitored to assist the Lab in planning for groundwater protection at that project site. The NuMI project site involved construction within the dolomite aquifer and therefore, Fermilab continues to analyze groundwater issues associated with it. To date, the investigation of impacts on groundwater from the NuMI construction site has shown no adverse effects on the potentiometric surface of groundwater in the Class I (potable resource groundwater as defined in Illinois Adminstrative Code, Title 35, Subtitle F, Chapter I, Part 620) resource beyond the Fermilab boundary. There have, however, been localized impacts to Fermilab operations in the area of the NuMI (Neutrinos at the Main Injector) tunnel. Currently, domestic water supplied to the west campus area at Fermilab is pumped from two relatively shallow wells that draw groundwater from the dolomite aquifer. One of these supply wells (W-1) is located approximately 1000 feet from the centerline of the NuMI beamline and has experienced a marked reduction in capacity due to the changed hydro-geologic conditions as well as age. In addition, ground motion studies within the 8 GeV beam line (from Booster to Main Injector) over the last 2 years has shown that flows greater than 100 gallons per minute from this well have impacted beam quality by causing small movements in accelerator components. For this reason W-1 was operated at very low flow during 2004 to avoid degrading beamline quality. Supply well, W-3, which was previously used for backup purposes, was the primary source of domestic water during 2004.

The Fermilab Lifetime Operating Air Permit was revised and reissued by the Illinois Environmental Protection Agency in 2004 to include a 2200 horsepower emergency diesel powered generator. The generator was installed for the purpose of ensuring the continuous operation of Fermilab's Feynman Computing Center (FCC) during scheduled and unscheduled power outages. In addition to meeting the critical need at FCC for uninterrupted service, this also eliminated the long periods of recovery time formerly required at FCC once power had been restored. The revised permit also incorporated the requirements for operating a gasoline dispensing facility Stage1 and Stage 2 vapor balance system; the Fermilab fueling station has been in compliance with these requirements since the vapor balance system was installed.

2.1 Other Environmental Issues

Twelve National Environmental Research Park (NERP) projects were conducted during 2004. The projects are the following: Differences in Reproductive Success of Prairie Plant Species between Restored and Remnant Prairies; Carbon Sequestration in Terrestrial Ecosystems; Assessment of the Impact of Biological

Controls on Garlic Mustard (*Alliara petiolata*) and on Non-target Species in Forest Communities; Bird Surveys at Fermilab; Feedbacks between Plants, Mycorrhizal Fungi, and Soil Nutrient Dynamics; Effects of Tree Removal on Recovery of Ground Cover in Big Woods at Fermilab; Bat House Project at Fermilab; Assessing Carbon Cycling in Restored Grasslands using Stable Isotopes; and Investigation of Carbon and Nitrogen Fluxes in Terrestrial Ecosystems at Fermilab; Mosquito diversity, density and microorganism productivity across spatial scales; Insect community restoration assessment within the Fermilab Prairie Restoration project; and Distribution and relative abundance of gray fox *Urocyon cinereoargenteus* in northeastern Illinois and possible interaction with coyotes.

The Laboratory's Ecological Land Management Plan[3] was updated in 2004. The plan can be viewed at www-esh.fnal.gov/ELM/ELM_Plan_2004.htm. Existing prairie tracts were enriched with forbs and burned or mowed to discourage intrusion of brush, trees and exotic plants.

The moratorium, issued by the Secretary of Energy in July 2000, on recycling of scrap metals from posted radiological or radioactive materials areas, remained in effect throughout 2004. Measures continued to be taken throughout 2004 at Fermilab to separate materials subject to this moratorium. Due to this, materials that were considered non-radioactive according to Fermilab's DOE-approved release criteria and which had been recycled prior to the moratorium continued to be amassed.

Fermilab carries out wildlife management to the extent necessary to protect the primary mission of the Laboratory and to preserve the Fermilab ecosystem. The Lab has a "nuisance animal" permit issued by the Illinois Department of Natural Resources (IDNR) that allows for the trapping and elimination of these nuisance animals. During 2004, six animals were destroyed. In addition, Fermilab intensively manages the population of whitetail deer on site to preserve the ecosystem. Fermilab contracts with the U.S. Department of Agriculture Wildlife Services Group to reduce the herd to an optimum number annually. This activity requires approval and permitting from IDNR; during 2004, 46 whitetail deer were removed.

2.2 Environmental Management Systems (EMS)

Executive Order (EO) 13148, *Greening the Government through Leadership in Environmental Management*, requires each Federal agency to implement an Environmental Management System (EMS) at its facilities by December 31, 2005. Subsequently, the DOE issued Order 450.1 to ensure execution of EO 13148 at all DOE facilities. An EMS is a continuous cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve compliance, pollution prevention, and continuous environmental improvement goals. In addition, a comprehensive EMS will assimilate the principles of the Integrated Safety Management System (ISMS) into an Integrated ES&H Management System (IES&HM), addressing facility operations hazards that have the potential to impact individuals and/or the environment.

In late 2003, the DOE Office of Environment, Safety and Health (EH) distributed a memorandum that requested follow-up information from area offices regarding the status of implementation of EMS's at all Office of Science (SC) sites. The request included a matrix implementation schedule spanning from FY2003 through FY2005 for seven EMS elements; the matrix was expanded to include eight EMS elements in early FY2004. Fermilab completed all of the FY2004 scheduled implementation items, which included the following: Establish Measurable Environmental Objectives and Targets, Establish Environmental Programs to Achieve EMS Objectives and Targets, and Establish EMS Awareness Training. In addition, in early CY2004 a revised Director's Policy was developed and endorsed by the Laboratory Director.

During June and July of CY2004, the DOE Chicago Office reviewed the implementation status and progress of EMS at Fermilab as part of the Fermi Site Office Operational Awareness Program. The assessment concluded that if Fermilab continues to progress and meets its stated commitments to the Fermi Site Office that it should be able to meet the scheduled EMS implementation deadline.

3.0 Environmental Monitoring and Surveillance

The goal of the Fermilab Environmental Monitoring Program (EMP) is to assist Laboratory management in decision-making by providing data relevant to impacts that Fermilab operations have on the surrounding environment. The EMP consists of effluent monitoring to confirm compliance with permits, generally at a particular point. Environmental surveillance is conducted at various locations to intercept the pathway of potential pollutants to receptors such as plants, animals or members of the public. Fermilab collects environmental data for reporting purposes or whenever it is necessary or useful in conducting the business of the Laboratory. Line organizations have the responsibility to recognize and understand the environmental aspects of their operations and to conduct their work in an environmentally sound manner.

The pathways available for movement of radioactive materials and chemicals from Fermilab operations to the public are the atmosphere, surface water and groundwater. Environmental surveillance consists of collecting and analyzing samples of various media and measuring penetrating radiation within and at the site boundaries.

Ground and surface waters are sampled at locations near operating areas, potential contamination sources and along potential transport pathways. In addition to air and water surveillance, samples of soil are collected and analyzed for radioactivity to ascertain whether there is build-up of radioactive materials in the environment due to long-term operations.

Surface water, air, groundwater, soil and sediment samples are analyzed for radionuclide concentrations. Surface waters are also monitored for potential chemical constituents. While levels of penetrating radiation are measurable near operational areas on the site, the levels decrease rapidly with distance from the sources. External penetrating radiation and airborne emissions are normally below instrument detection levels at the site boundary and must be estimated to provide information about the maximum potential radiation doses to offsite populations. The results of the environmental surveillance program are interpreted and compared with environmental standards where applicable. The Fermilab Environmental Monitoring Plan, which is maintained by the ES&H Section, provides more details.

The DOE advocates that sites address radiological protection of aquatic and terrestrial biota and has recommended that facilities review their monitoring programs for opportunities to improve and communicate their results. In response, Fermilab has used DOE's technical guidance (DOE-STD-1153-2002) and companion tool, the RAD-BCG Calculator, to evaluate the Laboratory's effect on both aquatic and terrestrial biota. On an annual basis soil and sediment samples are collected throughout the site in conjunction with water samples collected from sumps, ditches, and creeks according to routine sampling schedules. For the calendar year 2004, all locations analyzed passed the site screens. Thus, the radiological protection of biota is considered to be adequate.

3.1 Air Quality

The potential for public exposure to air pollution from Fermilab is very remote. Fermilab's Lifetime Operating Air Pollution permit issued by the Illinois Environmental Protection Agency (IEPA) under the Clean Air Act includes a *National Emissions Standards for Hazardous Air Pollutants* or NESHAPs element, which covers airborne radionuclides. In addition, the permit takes into account those criteria pollutants such as particulate matter, nitrogen oxides, carbon monoxide, volatile organic materials and sulfur oxides associated with the operation of various pieces of equipment.

Airborne radionuclides are normally released to the atmosphere from operating target stations. Measures to keep these releases as low as reasonably achievable (ALARA) are incorporated in these facilities. Monitoring is conducted at targeting areas where air emissions are considered a significant contributor to the overall

transport of radioactive materials offsite. The Magnet Debonding Oven at the Industrial Complex also contributes a small quantity of airborne radionuclides when operating. The permit application states that total releases will average no greater than 100 Ci/year with a maximum of 900 Ci/year.

The radiation doses potentially received by the offsite public due to Fermilab operations are calculated from data gathered through environmental surveillance of the onsite sources. Selected vent stacks are monitored directly with stack monitors and indirectly by taking soil samples in the vicinity of the stacks. The dose for the air pathway is calculated using a Gaussian plume computer simulation model called Clean Air Assessment Package-1988 (CAP-88PC2). This model was created by USEPA to predict the movement of airborne radionuclides and its use is required by regulations governing hazardous air pollutants at 40 CFR 61. Maximum calculated concentrations offsite are predicted to be below the level that could be detected by direct monitoring.

Fermilab is not a significant source of chemical air pollution. The permits cover emissions caused by open burning conducted for prairie/land management and fire extinguisher and firefighter training, a magnet debonding oven, a fuel dispensing facility, a vapor degreaser, an emergency standby diesel fuel fired generator, and the operation of several natural gas-fired boilers. Pollutant levels are estimated based on the knowledge of the processes that generate them and the characteristics of individual pollutants. The results are submitted to the Illinois Environmental Protection Agency in an annual air emissions report.

3.1.1 Radioactive Air Emissions

Debonding Oven operation is a potential source of tritium while radioactive components are being burned. In 2004 the debonding oven did not burn any radioactive magnets (there were other magnets burned); therefore there was no release of tritium from this source. The Anti-Proton Source, used in Colliding Beam operations, stack and the Mini Booster Neutrino Experiment (MiniBooNE) stacks together is estimated to have released a total of 23.2 Curies in 2004. These radioactive air emissions were less than 22% of the limits of the current air pollution permit application on file with the Illinois Environmental Protection Agency (IEPA). No detectable levels of radionuclides reached the site boundaries. Doses to the public from emissions in 2004 continued to be well below the Environmental Protection Agency (EPA) standard of 10 mrem/year to a member of the public and also much less than the EPA's continuous monitoring threshold of 0.1 mrem/year. Using the CAP-88PC2 gaussian dispersion model, the highest dose equivalent to any member of the public was estimated to be 0.00772 mrem.

Fermilab's 2004 Radionuclide Air Emissions Annual Report was submitted to DOE in May 2005.

3.1.2 Non-Radioactive Air Emissions

The IEPA decided in late 1996 that the level of air emissions at the Laboratory did not warrant the issuance of a Federally Enforceable State Operating Permit (FESOP) and therefore issued a Lifetime Operating Permit (LOP) to Fermilab in 1999. In 2000, the LOP was revised to add a vapor degreaser to the previously permitted air pollution sources; in 2004 the LOP was revised again to include one emergency standby diesel fuel fired generator located at the Feynman Computing Center. The current permit covers the Magnet Debonding Oven, three natural gas fired boilers at CUB, a 12,000-gallon gasoline storage tank with a Stage 1 and Stage 2 vapor balance system, accelerator tunnel ventilation stacks, a vapor degreaser at Industrial Building 3 and the standby diesel generator. Permit conditions require the monthly logging of fuel consumption for covered fuel combustion sources and solvent usage at the degreaser. Source operations were reviewed by Fermilab personnel again this year to ensure that permitted equipment continued to operate and be maintained in accordance with permit conditions. The Annual Air Emission Report for 2004, an estimate of criteria pollutant emissions, was submitted to the Illinois Environmental Protection Agency (IEPA) in May 2005.

3.2 Penetrating Radiation

Operation of the Fermilab accelerator and associated beamlines produce ionizing radiation such as muons. Beamlines and experiments are designed so that most of the radiation has ranged out before reaching the ground surface. The remaining radiation that emerges above the surface presents a small potential for radiation dose. Small muon fields have been measured in conjunction with the operation of the Fixed Target beamlines in the past. These beamlines were not operated in 2004. Since the removal of the Main Ring from the Tevatron tunnel, the A0 beam absorber replaced the C0 beam absorber as the primary absorber. Unlike the C0 absorber, the Tevatron beam has to be bent down into the ground to be directed to the A0 absorber. Due to this beamline feature, the ground absorbs the muons emerging from the A0 absorber. Therefore, no muons are detected from its operation. Both the MiniBooNE and NuMI experiments have the potential to produce measurable muon flux; however, the 8 GeV energy protons used in MiniBooNE are too low to produce muons that can escape the bulk shielding surrounding the experiment. The NuMI beamline bends the beam down so that the muons produced are absorbed deep underground.

Storage of radioactive materials at a centralized onsite location, known as the Railhead, resulted in another potential exposure to ionizing radiation. These sources of penetrating radiation were monitored continuously in 2004 by a large ionization chamber located in the Railhead colloquially called a 'Hippo.' The Hippo measurements are supplemented by periodic onsite surveys. Based on measurements made in 2004, it is estimated that radioactive materials stored at the Railhead contributed a dose equivalent at the site boundary in 2004 of approximately 0.067 mrem. The maximum radiation dose equivalent to an individual at the nearest offsite house was similarly estimated to be approximately 0.012 mrem in 2004.

3.3 Water Quality

Fermilab discharges liquid effluent to surface water bodies and to sanitary sewers. The Lab holds National Pollutant Discharge Elimination System (NPDES) permits that govern discharges to surface water from stormwater runoff, cooling water, and effluents from various onsite construction projects. In addition to monitoring for the physical and chemical parameters required by NPDES permits, samples of surface water are taken annually from selected water bodies and analyzed for radionuclides. These surface waters are sampled for radionuclides based upon their potential for contamination. Aqueous process wastewaters are directed to sanitary sewers and ultimately discharged to publicly owned treatment works (POTWs) in Batavia and Warrenville. Wastewater discharges are controlled by criteria set forth in the Fermilab Environment, Safety, and Health Manual Chapter 8025.

The NuMI construction project continues to be governed by a General NPDES permit issued by the IEPA covering construction related to mining activities. The permit was first issued in 1999 and subsequently renewed in 2002. This permit is primarily focused upon ensuring the safe discharge of effluents from the mining of dolomite during digging of the associated tunnel and providing erosion controls for construction areas and associated stockpiles. In concert with this project, several outfalls to onsite waterways were identified for monitoring. Monitoring for Total Suspended Solids (TSS), pH, and flow rate is performed at these NuMI-specific outfalls. In addition, the Corps of Engineers authorized NuMI activities for coverage under the Clean Water Act Section 404 permit program in August of 1999. This authorization was renewed in 2001.

The MiniBooNE construction project was completed in 2002; however, the project-specific Clean Water Act Section 404 wetlands permit remained in effect throughout 2004. This was done to ensure that the permit-imposed final stabilization of the area, which was disturbed during the temporary rerouting of Indian Creek, was adequately accomplished. A final inspection by the Army Corps of Engineers is necessary to close out both the NuMI and MiniBooNE wetland permits. Fermilab has formally requested that the Corps close out these permits and is awaiting the final inspection.

3.3.1 Radioactive Releases to Surface Water

Numerous sumps collect and drain water from building footings and from under beamline tunnels in the Tevatron, Main Injector and the Experimental Areas. Water collected by these sumps often contains detectable concentrations of radionuclides (primarily tritium, ^{3}H) that have been leached by rainwater from radioactive soil near beam targets and absorbers or released accidentally to sumps from beamline cooling water systems. These sumps discharge to ditches and ponds onsite. Surface water monitoring conducted during 2004 showed tritium concentrations to be well within the Department of Energy Derived Concentration Guides for allowable radionuclide releases to surface waters (2000 pCi/ml). Five of the fifty samples taken from onsite ditches, ponds and creeks in 2004 showed a detectable level of tritium, the highest of which was 44.8 pCi/ml. Samples taken at NPDES outfall (discharge) locations to *Waters of the State* (as defined by the Clean Water Act) showed no detectable tritium and gross beta levels well below IEPA allowable limits.

3.3.2 Non-Radioactive Releases to Surface Water

Monitoring for non-radiological chemical constituents in surface water was limited to NPDES permit parameters (temperature, flow, TSS, TDS pH, chlorine, chloride and sulfate) this year. Discharge Monitoring Reports for six different outfalls were submitted monthly to the IEPA. In 2004 there were no exceedances of discharge limits to *waters of the state*.

3.3.2.1 Cooling Water System

An NPDES permit authorizes the discharge of commingled cooling water and stormwater runoff to surface waters through outfalls to Kress, Indian and Ferry Creeks. Due to the presence of the RCRA-permitted (Resource Conservation and Recovery Act) Hazardous Waste Storage Facility onsite, the NPDES permit also regulates stormwater discharges from designated solid waste management units (SWMUs). The Stormwater Pollution Prevention Plan required by this NPDES permit is periodically modified to reflect changes that occur as part of the RCRA Facility Investigation (RFI) of the SWMU sites. Fermilab's site-wide NPDES permit dictates that water temperature, pH, and flow be monitored at all three outfalls; chlorine concentration be monitored at the Kress and Indian Creek outfalls; and total dissolved solids, chlorides and sulfates be monitored at the Indian Creek outfall. The monitoring results are reported to the IEPA on a monthly basis.

3.3.2.2 Releases to Sanitary Sewers

Another NPDES permit allows Fermilab to pre-treat and release effluent from the Central Utility Building (CUB) regeneration process to the City of Batavia sanitary sewer system. The pretreatment permit for the effluent generated by this process requires the collection and analysis of composite process effluent samples for specified metals on a quarterly basis. Samples were also collected and analyzed from each discharge for accelerator-produced radionuclides in order to confirm that amounts of radioactivity released meet DOE guidelines. In 2004, samples from the process effluent were in compliance with the specified levels in the Batavia Sanitary Sewage Ordinance and the Department of Energy Derived Concentration Guide. A total of 74,850 gallons of process wastewater were discharged to the Batavia sewer system; approximately 0.070 mCi of tritium and 126 uCi of ^{7}Be were released to the sanitary sewer from the CUB during 2004.

Monitoring stations, located at the site boundary, sample sewer discharges to the municipalities of Batavia and Warrenville. The discharge at these locations is a mixture of all effluents contributing to that sanitary sewer system. Analytical results are compared to municipal discharge limits to track compliance. In the past year, the Batavia sewer sampler revealed two exceedances of the iron discharge limit of 5.0 mg/l. The maximum level

measured was 7.44 mg/l. These excursions are likely the result of the aging pipe infrastructure and are of minimal impact to the Batavia treatment works.

3.4 Groundwater Quality

The Illinois Environmental Protection Agency (IEPA) publishes groundwater quality standards[4] and defines Class I groundwater as a non-degradable resource, which is to be highly protected. The water that is located in or near the dolomite aquifer 50 to 70 feet below ground surface of Fermilab is Class I groundwater according to criteria published by the IEPA.[5] Water in the overlying till has been demonstrated to be Class II water and therefore has less stringent standards.

Four background monitoring wells in locations upgradient to Fermilab operations continued to be utilized to obtain representative samples of the upper Class I groundwaters for chemical and radiochemical analysis. Ten wells at the Central Utility Building (CUB) Tile Field, four at the Meson and Neutrino Experimental Areas, and seven at Meson Hill were sampled as part of ongoing RCRA Facility Investigation (RFI) Corrective Actions at these sites. Over forty piezometers (pore-water pressure measuring instrument) were used to gather information on the direction of groundwater flow sitewide. The information collected is used in modeling the transport of potential contaminants from past and present operational areas of concern. Piezometers that had been installed as part of the NuMI site characterization were monitored to assist Fermilab in planning for groundwater protection at that facility. One of these was modified to accommodate sample extraction during CY2004. This location will be used to monitor for NuMI operational impacts to the Class I aquifer. Fermilab continues to analyze groundwater issues associated with this project that involved construction within the dolomite aquifer. To date, the investigation of impacts on groundwater from the NuMI tunnel has shown no adverse effects on the potentiometric (electromotive force) surface of groundwater in the Class I resource beyond the Fermilab boundary. There have, however, been localized impacts in the area of the tunnel to site operations. Currently, domestic water for supply to the west campus area at Fermilab is pumped from two relatively shallow wells that draw groundwater from the dolomite aquifer. One of these wells (W-1) is located approximately 1000 feet from the centerline of the NuMI beamline and has experienced a marked reduction in capacity due to the changed hydrogeologic conditions as well as age. Ground motion studies within the 8 GeV line (from Booster to Main Injector) conducted during CY2001 and CY2002 showed that flows greater than 100 gallons per minute from well W-1 will adversely impact beam quality. For this reason the well was operated at very low flow during CY2004 to avoid degrading beamline quality. Supply well W-3, which was previously used for backup purposes, was used during CY2004 for the main supply.

Thirty-five of one hundred-two-onsite groundwater monitoring locations was sampled during the year for radionuclide or chemical parameters. The remainder was available for water level monitoring.

3.4.1 Groundwater Characterizations

There were no groundwater characterizations conducted during CY2004.

3.4.2 Monitoring Well Modification and Abandonment Activities

There were no monitoring well modifications or abandonment activities during CY2004.

3.4.3 Radionuclides

The Department of Energy groundwater concentration guide and the Illinois Class I groundwater standard for tritium is 20 pCi/ml. Quarterly samples were taken at one Solid Waste Management Unit (SWMU) per the conditions of the RCRA RFI (see Section 4.12.1, RFI Activities). Outside of the RFI, 17 samples were taken from 14 locations for analysis. Radionuclides were not detected in any samples taken during CY2004 in Class I groundwater.

3.4.4 Chemicals

Two rounds of groundwater samples were collected for chemical analysis in 2004 at two Solid Waste Management Units (SWMUs) under the RCRA RFI. (See Section 4.12.1 RFI Activities.)

4.0 Compliance with Specific Environmental Regulations

Below is a summary of Fermilab compliance with key environmental regulations.

4.1 Clean Air Act

Open burn permits to allow prairie/land management burning, maintenance of Meson Hill and fire extinguisher training were renewed by the IEPA in 2004. The annual air emissions report for 2004 was submitted to the IEPA in April 2005 and the annual radionuclide emissions report was submitted to the USEPA in June 2005.

An estimated 23.19 Curies were released in conjunction with the operation of the Fermilab Anti-Proton Areas stack in 2004 and the MiniBooNE Project (a Fixed Target experiment) stack. The Magnet Debonding Oven, a potential source of tritium, did not burn any radioactive magnets in 2004. The CAP-88PC2 dispersion model calculated the maximum dose equivalent delivered to a member of the public (at the boundary of the lab) to be 0.00772 mrem/year due to 2004 Fermilab operations. This was a slight increase from the 2003 calculated maximum dose equivalent of 0.00686 mrem/year that resulted from a 56% increase in beam targeted at MiniBooNE. The collective effective dose equivalent for 2004 was estimated to be 0.0252 person-rem.

Fermilab is registered with the Clean Fuel Fleet Program (CFFP); one of several programs the IEPA has implemented to help improve air quality in the Chicago ozone non-attainment area.

4.2 Underground Storage Tanks

No compliance issues were identified in 2004. In 2003, an additional underground fuel tank was installed at Site 38, bringing the number to three. The new tank is ten thousand gallons in capacity and contains an Ethanol 85 (E85) blend. The three Underground storage tanks (USTs) in use at the Fermilab Site 38 Fuel Dispensing Facility were operated and maintained per current UST standards prescribed by the USEPA (40 CFR 280.80) and the Illinois State Fire Marshall.

4.3 The Endangered Species Act of 1973

No compliance issues were identified in 2004.

4.4 Executive Order 11988, "Floodplain Management"

No compliance issues were identified in 2004.

4.5 Clean Water Act Section 404 (and Executive Order 11990, "Protection of Wetlands")

Pre-evaluation of Fermilab activities in wetlands continued to be accomplished through the NEPA review process and construction design reviews. The Lab continues to use task manager/construction coordinator training to instruct participants regarding how to ensure that potential work areas are screened for the presence of wetlands and to be aware of all aspects of environmental compliance management.

Fermilab currently holds two permits under Section 404 of the Clean Water Act. One permit was obtained in 2000 for the NuMI project, to construct an access road from the Lederman Center west to the MiniBooNE parking lot. The other permit governed the rerouting of a portion of Indian Creek to allow for the construction of the MiniBooNE experiment. There was no activity under either permit in 2004.

4.6 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

In 2004, the use of pesticides and herbicides at Fermilab was handled in accordance with FIFRA.

4.7 Illinois Department of Natural Resources "Rules for Construction and Maintenance of Dams"

Fermilab holds an Illinois Department of Natural Resources (IDNR) issued permit that classifies the Main Injector berm as a small Class III dam. The dam provides limited flood control to areas downstream from the Lab in the Indian Creek watershed. On a five-year cycle Fermilab is required to perform a comprehensive inspection and file a detailed report on the condition of this structure. The last comprehensive inspection was conducted in April of 2003. Only minor maintenance issues were discovered at that time and all of those were addressed then. In addition, there is an annual visual examination of the Class III dam. No action items were identified during the 2004 examination.

4.8 The Migratory Bird Treaty Act

Fermilab maintains a permit from IDNR (acting for U.S. Fish and Wildlife Service) to destroy nests of Canada geese in the vicinity of the Children's Center only if they become a safety hazard. The permit allows destruction of up to ten nests each year. During 2004, three nests containing a total of seven eggs were destroyed at the Daycare Center.

4.9 National Environmental Policy Act (NEPA)

Fermilab met the requirements of this Act by continuing to implement a program of reviewing all activities for compliance as set forth in the Fermilab Environment, Safety and Health Manual (FESHM) Chapter 8060. FESHM Chapter 8060 – NEPA Review Procedure – was revised in 2003 to clarify when NEPA review was

required and specifically what the review should entail; the approach to determining NEPA applicability was refined and several definitions were improved upon. DOE approved five projects for Fermilab as being categorically excluded (CXs) from further review in 2004.

4.10 National Historic Preservation Act (NHPA), Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act (NAGPRA) of 1990

Compliance with these Acts was accomplished through the NEPA review process that included an evaluation of all proposed land-disturbing projects in 2004 to assess any potential impacts on historic resources. No compliance issues were identified in 2004.

A DOE requested Cultural Resources Management Plan (CRMP) following guidelines outlined in DOE Publication DOE/EH-0501, was prepared and completed for Fermilab in 2002. The CRMP assures continued compliance with the above listed Acts by providing a comprehensive overview for the locations and status of all archaeological resources within the Fermilab site boundaries thereby facilitating future NEPA reviews.

4.11 National Pollutant Discharge Elimination System (NPDES)

Fermilab held five IEPA issued NPDES permits in 2004. Of the five, three permits were associated with stormwater management at construction sites greater than one acre. Two of the projects were completed in 2004 and the permits were subsequently closed. Fermilab continues to hold a NPDES permit covering activities related to the completion of the NuMI project and a site wide permit covering industrial discharges. There were no reported discharge violations reported to IEPA.

4.12 Resource Conservation and Recovery Act of 1976 (RCRA)

The Annual Hazardous Waste and Illinois Generator Non-Hazardous Special Waste Reports for 2004 were submitted to the DOE Fermi Area Office in January and February 2005 respectively. DOE subsequently submitted these reports to IEPA.

The following volumes of non-radioactive waste were generated by Fermilab and managed for disposal by the Hazard Control Technology (HCT) Team of the Safety and Environmental Protection Group in 2004.

43.2 m^3	Non-Routine Hazardous Waste (RCRA + TSCA)
5.6 m^3	Routine Hazardous Waste (RCRA + TSCA)
20.5 m^3	Non-Routine Non-Hazardous (Special) Waste
34.8 m^3	Routine Non-Hazardous (Special) Waste
8,368.5 m^3	Dumpster/Landfill Waste

4.12.1 RFI Activities

As a condition of the Lab's RCRA Part B permit, the IEPA required Fermilab to undertake a RCRA Facility Investigation (RFI). The purpose of the RFI was to investigate whether hazardous constituents had been released to the environment from identified solid waste management units (SWMUs) located onsite. In addition to requiring the reporting of newly identified SWMUs, RCRA also required that IEPA be notified of any changes to previously identified SWMUs. A total of three SWMUs are still being addressed in accordance with the corrective action requirements of Fermilab's RCRA permit: the CUB Pipe and Clay Tile Field, the Meson and Neutrino Experimental Areas, and Meson Hill. Further investigation is not required at the Village Machine Shop, the Railhead Storage Yard, and the IB2 Industrial Building so long as institutional controls remain in place.

IB2 Industrial Building

A paper trail and chronological investigation for this area was conducted as part of the permit renewal process for the Laboratory's RCRA Part B permit. Information was forwarded to the IEPA about the infiltration barrier and administrative controls associated with this area.

Village Machine Shop (SWMU# 5)

No new information was requested or generated at this unit during CY2004.

CUB Tile Field (SWMU# 12)

The CUB Tile Field has previously been removed along with all chromate-contaminated soil and gravel. The soil was properly disposed of and the surrounding soil sampled and analyzed. Fermilab continues to monitor all of the CUB Tile Field wells semi-annually. Monitoring wells at SWMU 12 were sampled during the 2nd, and 4th quarters of the calendar year. Wells MWS2, MWS3 and MWD1 indicated chloride levels above the Class II standard in CY2004.

Meson Hill (SWMU# 13)

Closure activities for Meson Hill were completed in 1998. This included moving concrete, grading, installing a clay cap, placing topsoil on the clay cap, hydroseeding the top of the hill, and a site inspection. Fermilab continues sampling of all monitoring wells installed at this unit on a semi-annual frequency. Analysis of groundwater from the monitoring wells screened within the upper Quaternary deposits has shown elevated concentrations of total dissolved sulfate and associated total dissolved solids above the 99% confidence level and Class II groundwater standards.

An Assessment Monitoring Plan was developed, reviewed and accepted by the IEPA in CY2001 as a result of the continued monitoring results of elevated concentrations of total dissolved sulfates and associated total dissolved solids, and implemented and reported to the IEPA during CY2002. The plan was developed to determine the source of the increase, concentrations and extent of sulfate migration, and assess any potential threat to human health and the environment. Results from the study indicated natural conditions were the source of the detected sulfate concentrations and that there was no potential threat to human health and the environment.

Monitoring wells at SWMU 13 were sampled during the 2nd, and 4th quarters of CY2004. Statistical analyses confirmed that the concentrations of total dissolved sulfates in samples from monitoring wells G101, G102, G103, G104, G105 and G106 have continued to exceed the 99% confidence level. Concentrations of total dissolved sulfate in monitoring well G101 also exceeded the Class II groundwater standard during both

quarters and G105 exceeded the standard during the second quarter sampling. Due to the elevated concentrations of sulfates and associated total dissolved solids, updated notifications of a "significant change in groundwater quality" were sent to the IEPA in conjunction with both CY2004 semi-annual analytical reports.

A directive was received from IEPA in August 2002 requiring the replacement of the background monitoring well at the RCRA unit. A post closure modification request was developed and forwarded to IEPA detailing the investigation, installation and sample process for the proposed background-monitoring well. IEPA responded in January 2003 approving the post closure modification request with conditions and modifications. The new background monitoring well was installed on May 22, 2003. Sampling of this monitoring point began with the second quarter CY2003 semi-annual monitoring and continued through the fourth quarter CY2004. A new 99% confidence level will be established for the second quarter sampling of CY2005.

Railhead Storage Yard (SWMU #14)

No information was requested or generated at this unit during CY2004.

Meson/Neutrino Soil Activation Areas (SWMU #15)

Fermilab continues to sample four monitoring wells at this unit on a quarterly schedule for accelerator-produced radionuclides. The results of samples from the Class I groundwater along with flow directions in the upper dolomite are reported annually to IEPA. No radionuclides were reported in these monitoring wells above detection levels during CY2004.

4.13 Safe Drinking Water Act

Fermilab provides drinking water to its employees through two Fermilab-operated public water supplies and a satellite supply connected to the City of Warrenville public water supply. Full jurisdiction for Fermilab's public water supplies was transferred from the Illinois Environmental Protection Agency (IEPA) to the Illinois Department of Public Health (IDPH) in 1996. Initially, this involved an IDPH review of the existing monitoring program, which determined that the program was compliant with their regulations.

During 2004, water samples were collected and analyzed for required parameters and at the prescribed frequencies in compliance with United States Environmental Protection Agency (USEPA) Regulations and the Drinking Water Systems Code (DWSC) adopted by the Illinois Department of Public Health. All results were acceptable with the exception of copper in the Main Site Supply, which exceeded the *action level* as defined in the DWSC. While the *action level* was exceeded, no action was deemed necessary by IDPH.

4.14 SARA TITLE III or Emergency Planning and Community Right-To-Know Act of 1986 (EPCRA)

Under these regulations Fermilab is required to provide the EPA, State, and local officials with an annual accounting of hazardous, toxic, and extremely hazardous chemicals used or stored onsite in quantities greater than a given threshold. Fermilab filed a Toxic Chemical Release Inventory Report (TRI) for 2004 with the USEPA and IEPA in June 2005. Copper was the only toxic chemical processed or used at Fermilab at threshold activity levels defined by SARA Title III Section 313. As required by Section 312 of SARA Title III, Fermilab also submitted a Tier II Emergency and Hazardous Chemical Inventory (2004) to State and local emergency services and disaster agencies in February 2005.

4.15 Oil Spill Prevention

Oil inventory at Fermilab consists of numerous oil-filled electrical transformers ranging in volume from 4 gallons to 17,300 gallons. There are no above ground oil storage tanks at Fermilab. Potential onsite oil spill sources are located such that surface water discharge spillways can be effectively used to prevent any oil spills from leaving the site and entering regulatory defined *state waters*. The only exception is the transformer at Giese Road (1695 gallons) near Indian Creek. This transformer was previously located downstream of the Indian Creek outfall to *state waters*. Even though the outfall has been moved to a location further downstream in Indian Creek, this transformer still has the potential to spill into regulated waters because there is no in-stream mechanism to prevent a discharge from making it to *waters of the state*. As an added precaution, the Giese Road transformer and others onsite utilize secondary containment. In accordance with 40 CFR 110-112, Fermilab maintains a Spill Prevention Control and Countermeasures plan (SPCC) for the Giese Road transformer; this plan is periodically reviewed and revised as necessary.

Fermilab experienced an unexpected oil spill on August 31, 2004 resulting from the failure of equipment associated with a Central Helium Liquifier (CHL) Coldbox. The equipment contains a heat exchanger that utilizes industrial cooling water (ICW) to dissipate heat from its oil reservoir. Because the normal operating pressure of the oil side of the heat exchanger exceeds the ICW pressure, when a lead developed between the two, the oil began to contaminate the ICW. The equipment failure occurred when the oil pressure in the exchanger exceeded the water pressure and the oil contacted the cooling water. The cooling water from the heat exchanger discharges via a pipe to a manhole that is part of the site storm drainage/ICW system and eventually accumulates in Bull Rush Pond. Approximately 27 gallons of mineral oil were released into Bull Rush Pond prior to spill discovery, source identification, and equipment shut down. The spill was confined because the only outlet from Bull Rush Pond is via a lift station whose pump inlets are too deep to entrain floating oil.

The Fermilab Fire Department initially responded to the spill by utilizing oil absorbent booms and pads. Subsequently, an environmental cleanup contractor cleaned up most of the oil on September 2, 2004. Additionally, the Accelerator Division ES&H Department personnel continued to remove residual oil from the drainage ditch until mid-November.

In response to this incident, the following actions are underway:

1. A vendor has been contracted to determine the exact failure mechanism of the heater exchanger.
2. Equipment and procedural modifications are being implemented to:
    a. eliminate the potential for bacterial corrosion (a possible cause of the equipment failure)
    b. ensure earlier problem detection by operators
    c. containment of spilled oil prior to release into manholes

3. All divisions/sections have been asked to inventory similar equipment and evaluate the vulnerabilities of potential environmental receptors.
4. Local spill control plans will be developed/updated as appropriate.

4.16 Toxic Substance Control Act (TSCA)

In April 2003, Fermilab sampled groundwater at two Tevatron service buildings as a follow-up to clean up of Polychlorinated Biphenyl (PCB) contaminated soil resulting from past management practices at the transformer yards associated with these buildings. Groundwater that had seeped into the excavations during the 2002 remedial activities at B1 and B4 service buildings were found to be above the standard for unrestricted release. Consequently, although they met the standard for soil cleanup, these two sites could not be declared, “clean” at that time. Groundwater was not encountered during the 2003 sampling activities at B1,

suggesting that contamination at this location was limited to the water removed during the initial excavation. Therefore, remediation at B1 is now considered complete.

Conversely, the 2003 samples from B4 again indicated contamination in some locations was slightly above the standards. When PCB-contaminated groundwater is encountered, EPA regulations dictate that the owner consult with the Agency and the Agency decide, based upon risk, whether further remediation is necessary. To obtain such a decision, Fermilab prepared a report on the results of its groundwater investigation and DOE transmitted it to the EPA on September 22, 2003. In the report, Fermilab concluded that the remaining contamination was very low-level and sufficiently localized that it did not pose any significant environmental threat. The Lab therefore, requested that the Agency classify the residual PCBs as "disposed in place." Despite a teleconference meeting between EPA responsible personnel and Fermilab and Fermi Area Office staff in December of 2004, a response has not been formally issued by the EPA.

4.17 Pollution Prevention and Waste Minimization

Fermilab received two environmental awards from the DOE Office of Science and one from the Illinois Governors Office in 2004. One DOE award was given for an Accelerator Division multi-year project that involved the repositioning of batteries that power emergency lights in accelerator and fixed target tunnels to locations further away from beamline enclosures. This project was undertaken to prevent the emergency light batteries from becoming activated and the subsequent potential of creating mixed waste. The second DOE award was given for the Particle Physics Department retrofit of the D-Zero liquid nitrogen recovery system. The retrofit dramatically increased the efficiency of the liquid nitrogen recovery system, which subsequently reduced the heat load on other systems. This resulted in an annual reduction of 207,000 gallons of liquid nitrogen that translates into a savings of approximately $43,000 per year. An Illinois Governor's Pollution Prevention Award was also granted to Fermilab for this retrofit.

Also in 2004, the Pollution Prevention (P2) Program received elevated status as an integral part of Fermilab's new Environmental Management System. The EMS further expands the opportunity for lab personnel to explore and document P2 activities. In addition to the above-mentioned projects, below are further examples of P2 related activities that occurred in 2004.

The Laboratory's efforts to segregate recyclable materials at construction/demolition projects resulted in a considerable increase in the quantity of material diverted from disposal and sent for recycling. For example, 85% of the resulting material from a major renovation undertaken by the Technical Division at Industrial Building 3 was sent for recycling. Additionally, metal containing materials from various dismantling projects were targeted for metals recovery. For example, 30 tons of zinc was recovered from the dismantling of the Fixed Target Bubble Chamber and 14,000 pounds of a variety of metals was recovered from dismantling of the Wide Band Lab. Site wide, over 600 tons of scrap metal was recycled in 2004.

Also in 2004, personnel from the Accelerator Division (AD) expanded their scrap metal recycling program to include electrolytic capacitors, which for many years were disposed of as trash; began recycling of empty paint cans; and enhanced their rechargeable battery program (for portable small equipment). Additionally, the Lab wide contract for recycling of spent fluorescent light bulbs was awarded to a vendor that recovers more of the mercury from the fluorescent bulbs.

Finally, Laboratory Services Section personnel secured a new energy efficient air-cooled icemaker for the Wilson Hall kitchen. The previous water-cooled icemaker consumed approximately 1,600 gallons of domestic water per day (2% of lab wide usage) to produce 800 pounds of ice daily at full capacity. The new unit produces 1000 pounds of ice daily while water consumption remained constant.

5.0 Conclusion

The operations at Fermilab during 2004 had no significant adverse impact on the environment or on public safety.

[1] Details of the Fermilab Environmental Monitoring Program (FEMP) can be found on the ES&H home page.

[2] Supporting data are available upon request from the Fermilab ES&H Section.

[3] Fermilab Annual Ecological Land Management Plan for calendar year 2004.

[4] 35 IAC 620

[5] 35 IAC 620.210